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Anatomic variations of the radial artery: Significance when harvesting for coronary artery bypass grafting

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Over the past decade, the radial artery (RA) has gained wide acceptance as a useful vascular conduit for coronary artery bypass grafting with a very good mid-term patency rate.

In addition to preoperative assessments of the ulnar artery collateral blood supply, it is crucial to understand the anatomic details of the RA harvesting site to avoid neurovascular complications of the forearm. Because anatomic variations of the RA in the arm are common in human subjects,[1,2] it is more likely that these complications are even higher in frequency.[3] We have encountered a left arm duplication of the RA where this vessel runs above the deep fascia in the proximal and mid forearm, and its course is somewhat more medial than when the RA is located beneath the deep fascia. This vessel is called the superficial RA. We discuss the anatomic findings, and on the basis of our observation in this case, we recommend that the incision should be slightly modified and should be placed more medially along the medial border of the flexor carpi radialis muscle.

Anatomic Findings

The anatomic variation was discovered intraoperatively when an accessory RA branch (or duplication) was found. We designated this anatomic variation as the RA accessory because of its significant size. The superficial branch RA (Figure 1), the larger of the two, has made itself quickly apparent just below the cubital fossa and has descended in the upper and mid forearm accompanied by a significantly large lateral brachiocutaneous nerve. Both the vessel and the nerve were located beneath the superficial fascia and were found in the subcutaneous tissue instead of being concealed by the brachioradialis muscle, as is normally the case. The true deep branch RA (Figure 2) and the superficial branch of the radial nerve remained lying anterior to the teres major muscle in the upper forearm and then anterior to the flexor digitorum superficialis and the flexor pollicis longus muscles in the lower forearm, respectively. Notably, the superficial and deep RAs, as well as the lateral brachiocutaneous nerve, have remained in a more superficial plane than the flexor carpi radialis muscle and were somewhat in a more medial position. Had a more lateral incision been made, these 3 structures would have been in harm's way, being located directly under the skin and in a more medial and superficial positions beyond the medial portion of the brachioradialis muscle.

Surgical Technique

Having taken heed of this anatomic variation of the RA, we describe herein and have recently adopted a slightly modified technique of harvesting. It consists of making a more medial curvilinear incision bordered by the midportion of the flexor carpi radialis muscle belly in the upper two thirds of the forearm. The incision is continued all the way down to the white, shiny nacre and flat tendon of that muscle located in the lower third of the forearm. This incision is a slight modification of the one described by others,[4] in which the incision stopped at the lateral border of the brachioradialis muscle. With the intent of protecting the neurovascular structures, the dissection begins and proceeds from the medial to lateral regions of the forearm once the entire course of the flexor carpi radialis muscle is visualized under the incision. The remainder of the dissection continues as traditionally practiced.

All wounds have healed with no hand ischemia, and no skin flap necrosis was observed. Of the 520 RAs harvested with this technique by one surgeon (AKA), only one patient experienced temporary distal forearm dysesthesia, and he fully recovered his sensation within 6 weeks.

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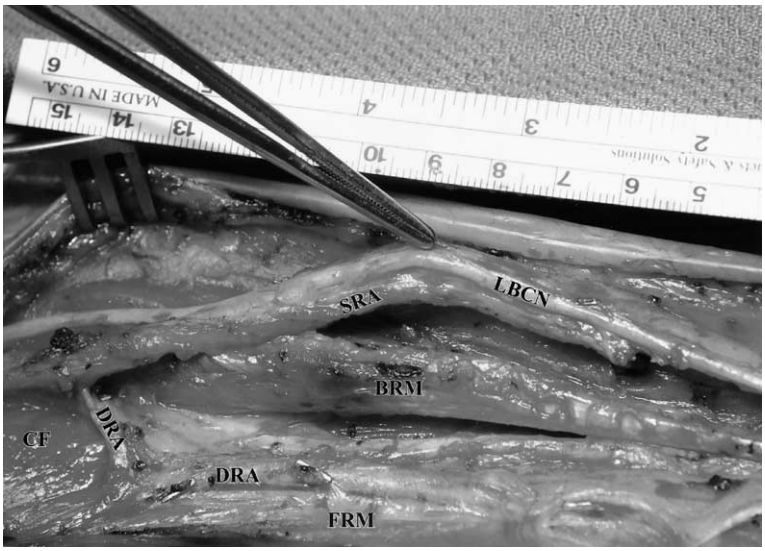

Figure 1. Intraoperative findings of a left RA duplication. The superficial RA branch *(SRA)* and the lateral brachiocutaneous nerve *(LBCN)* are anterior to the brachioradialis muscle *(BRM)*. Note that the deep RA branch *(DRA)* lies on the medial portion of the belly of the flexor carpi radialis muscle *(FRM)* near the cubital fossa *(CF)*.

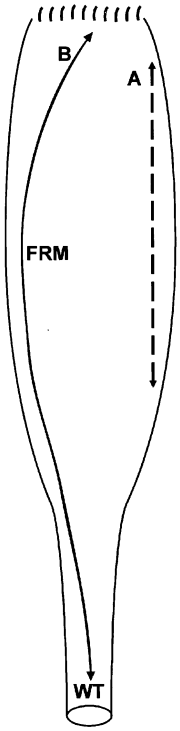

Figure 2. Cartoon showing left arm line of dissection *(B)*. It starts cephalad over the medial fleshy belly of the flexor carpi radialis muscle *(FRM)* near the cubital fossa and ends over its white tendon *(WT)* just at the level of the wrist crease. The conventional line of dissection *(A)* is also shown.

Discussion

The most frequently encountered distal anatomic variation of the RA is a rather sizable palmar branch (but more slender than the RA itself) located in a more superficial plane than the tendon of the flexor carpi radialis muscle and situated on its radial side before turning to the dorsum of the hand at the distal extremity of the radius. This distal variation does not require any modification in the technique described in this article. However, troublesome bleeding from injury to these not-so-small vascular branches might occur during operations performed by those who are less familiar with such subtle anatomic variations.

Theoretically, unusual findings suggested by pulse or Doppler vascular signals being in the wrong place might indicate a developmental variation of forearm arterial anatomy. However, our case was unsuspected on the preoperative screening tests.

In an extensive series of dissected specimens of 750 upper extremities, McCormack and colleagues[1] reported an incidence of 6 RA duplications. These brachial and antebrachial arterial variations are probably caused by an abnormal embryologic development of the vascular plexus of the limb buds.[5] Because upper extremity angiography is not routinely done preoperatively, these malformations will remain an intraoperative incidental finding and cannot be identified beforehand. Their incidence has been reported at between 1% and 15%, depending on their location in the upper or lower forearm, respectively. We have yet to find an RA that skirts the most medial border of the flexor carpi radialis muscle. One has to be mindful of the fact that during the positioning for procurement of the RA with the arm outstretched and draped on an arm board, the tendency is for it to be pronated. This position will render the skin incision a bit more lateral than the operating surgeon intends. Therefore the arm should be anchored in a supination position. We conclude that the placement of a more medial incision and referencing the middle fleshy portion of the flexor carpi radialis muscle as the starter line of dissection protects the

local neurovascular structures from trauma and resultant postoperative morbidity. Although this procedure carries recognized neurovascular complications, this technique has proved safe and successful in preventing them.

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Retrograde segmental aortic repair for type II thoracoabdominal aortic aneurysm

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Surgical treatment of type II thoracoabdominal aortic aneurysms (TAAAs) is associated with high morbidity and mortality[1] because the procedure is complicated and adjuncts for spinal cord and visceral protection are required. To this end, a distal aortic perfusion through a left heart bypass has recently been used in type II TAAA repair.[2,3] We have been using partial femorofemoral bypass as a distal aortic perfusion in the treatment of descending thoracic aortic aneurysms and TAAAs.[4,5] However, we have became aware that a retrograde perfusion from the femoral artery carries the risk of producing a malperfusion of visceral organs in a chronic aortic dissection. We therefore have modified our technique for this lesion.

Patients and Methods

Patient data. Five patients with a chronic aortic dissection underwent TAAA repair with the modified technique. They ranged in age from 26 to 65 years with a mean of 49 years. Four patients had a typical Marfan syndrome and had previously undergone cardiovascular operations for a DeBakey type I dissection with aortic root, a total arch, and either proximal descending thoracic replacement or the elephant trunk technique. The remaining patient did not have Marfan syndrome and showed a DeBakey type IIIb dissection. A preoperative aortogram and computed tomographic scanning showed a diffuse aneurysmal formation of the thoracoabdominal aorta and perfusion of some visceral arteries from the false lumen, suggesting a potential risk of organ malperfusion if a retrograde perfusion were to be used (Figure 1).

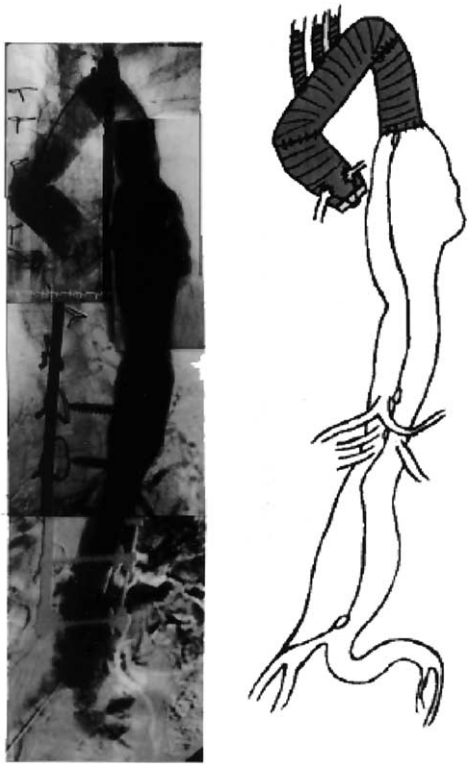

Figure 1. Preoperative aortogram *(left)* and diagram *(right)* of patient with Marfan syndrome who had previously undergone aortic root replacement with composite valved conduit, total arch, and proximal descending aortic replacement showing complicated circulatory status of visceral arteries.

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